UNITED STATES GENERAL ACCOUNTING OFFICE

REPORT TO THE CONGRESS

Cost, Schedule, And Design Aspects Of Selected Atomic Energy Commission Construction Projects B-164105

B-164105

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the cost, schedule, and design aspects of selected Atomic Energy Commission construction projects.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget, and to the Chairman, Atomic Energy Commission.

Elmer B. Staats

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

COST, SCHEDULE, AND DESIGN ASPECTS OF SELECTED ATOMIC ENERGY COMMISSION CONSTRUCTION PROJECTS B-164105

DIGEST

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WHY THE REVIEW WAS MADE

The Atomic Energy Commission (AEC) provides funds for the construction of large facilities used in connection with its research activities and development programs. Because of congressional interest in such construction projects, the General Accounting Office (GAO) selected five projects for review: the 200-billion-electron-volt (Bev.) accelerator laboratory, the Loss of Fluid Test Facility, the Power Burst Facility, the Fast Flux Test Facility, and the Hot Fuel Examination Facility.

The 200-Bev. accelerator laboratory was selected for review because of the substantial costs to be incurred in its construction, estimated by AEC at $250 million. The remaining projects were selected because, during a review of certain reactor development activities, GAO had seen indications of cost increases or schedule slippages and had decided to inquire into the causes.

FINDINGS AND CONCLUSIONS

Cost estimates

GAO reviewed AEC's June 1970 cost estimates for the five projects, as shown below. As of May 1971 AEC's total cost estimates for these projects remained the same.

Project	Year authorized	Cost estimates: At time authorized	Cost estimates: At June 1970	Increase
		(millions)		
200-Bev. accelerator laboratory	1967	$250.0	$250.0	$ -
Loss of Fluid Test Facility	1963	17.6	35.0	17.4
Power Burst Facility	1964	8.1	16.1	8.0
Fast Flux Test Facility	1966	87.5	102.8	15.3
Hot Fuel Examination Facility	1968	10.2	10.2	-

AEC has advised the Congress of the revised cost estimates. (See pp. 27, 30, and 35.)

AUG. 17, 1971

For the three projects that have experienced increases in estimated construction costs, related estimates of operating funds which are expected to be expended during the projects' construction periods also have increased substantially over original estimates. (See pp. 28, 33, and 37.)

In June 1970 the organization responsible for construction of the 200-Bev. accelerator laboratory did not have a current estimate of total project costs. At GAO's request the laboratory and the architect-engineer prepared estimates of the total costs of various project components as of June 30, 1970. GAO assembled these estimates which totaled about $240 million. (See pp. 11 to 16.)

AEC advised GAO that the $240 million estimate did not appear to be unreasonable as a working estimate of the project, which was 24-percent completed in June 1970. AEC indicated, however, that, because of the complexities and the remaining uncertainties facing the project, costs could not be predicted with sufficient accuracy to warrant revising the official estimate of $250 million. AEC expressed the belief that the project would be completed within the $250 million authorization. (See pp. 14 and 15.)

Construction schedule

The 200-Bev. accelerator laboratory was expected to be completed on schedule in 1973. Laboratory officials estimated that a 200-Bev. beam would be achieved by June 1971, about 1 year earlier than originally anticipated. (See p. 17.) The other projects had experienced slippages in their estimated completion dates.

The estimated completion dates of the Loss of Fluid Test Facility and the Power Burst Facility have been extended about 6 years and 4 years, respectively. Delays of both projects have resulted from design revisions, procedures instituted to upgrade engineering, and management direction problems. Measures were taken by AEC to resolve these problems. (See pp. 23 to 27, and 31 to 33.)

The completion of the Fast Flux Test Facility and the Hot Fuel Examination Facility has been delayed about 1 year. In a September 23, 1970, report to the Congress on the "Problems in Developing the Atomic Energy Commission's Fast Flux Test Facility" (B-164105), GAO noted that the delay of the facility had been caused by management problems and that action was being taken to resolve these problems. (See pp. 37, 39, and 43.)

According to AEC the delay of the Hot Fuel Examination Facility was attributable, in large part, to the fact that funds for design work were not available as early as anticipated. (See p. 43.)

Design changes

Significant changes have been made to each of the construction projects.

The 200-Bev. accelerator laboratory is being constructed to incorporate the capability to obtain energy levels as high as 500 Bev. under modified operating conditions. Also several minor design changes have been made, which are not expected to adversely affect the operating capability of the accelerator. (See pp. 17 to 19.)

Substantial design changes have been made to the Loss of Fluid Test Facility and the Power Burst Facility, which have been accompanied by modification and/or expansion of their original test programs. (See pp. 21, 22, and 29 to 31.)

The definitive design for the Fast Flux Test Facility included a plant concept similar to that expected to be used in commercial fast breeder reactors. The initial estimated cost for the project, which was based on a management assessment of many different reactor concepts, has been increased by about $15 million. (See pp. 35 to 37.)

Since authorization of the Hot Fuel Examination Facility, design modifications--resulting in cost reductions of about $1.2 million--have been made to maintain the $10.2 million cost estimate. Also about $5 million is to be invested in the upgrading of the Fuel Cycle Facility, a nearby test facility, principally to augment the capabilities the Hot Fuel Examination Facility. (See pp. 40 to 45.)

GAO believes that AEC should have informed the Congress that it was considering the modification of the Fuel Cycle Facility at the time authorization was requested for the Hot Fuel Examination Facility. AEC stated that such advice had been omitted by oversight and that it had been provided to the Congress later, during the fiscal year 1971 authorization hearings. (See pp. 41 and 42.)

Reporting system

Reports were prepared periodically, usually monthly, and were designed to communicate information to AEC concerning changes in cost, schedule, and designed aspects of construction projects. GAO believes that these reports provided adequate mechanisms for communicating this information. (See pp. 46 to 49.)

AEC has supplied the Congress with current cost and schedule information regarding the projects included in GAO's review. Also AEC has given substantial information to the Congress concerning the design aspects of its various construction projects. (See p. 49.)

With respect to the 200-Bev. accelerator laboratory, GAO believes that the contractor's practices for developing current working cost estimates reported to AEC should be strengthened tp providea better basis for analysis and evaluation. (See p. 49.)

RECOMMENDATIONS OR SUGGESTIONS

AEC, together with appropriate contractor officials, should review the contractor's cost-estimating practices used for the 200-Bev. accelerator laboratory and should make appropriate revisions to ensure that estimates prepared by the contractor are documented adequately to facilitate effective analysis and evaluation. (See p. 49.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

AEC pointed out that the 200-Bev. accelerator laboratory project was being carried out in a highly satisfactory manner and that it was expected to be completed within the original time and cost estimates and to exceed its performance objectives. AEC agreed, however, that the contractor's estimating practices should be strengthened and took steps to improve these practices. (See pp. 49 and 50.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

GAO is issuing this report because cost levels, maintenance of schedules, and design changes of large construction projects of departments and agencies of the Federal Government, paid for with public funds, are matters of special concern and interest to the Congress.

Contents

ABBREVIATIONS

AEC	Atomic Energy Commission
FFTF	Fast Flux Test Facility
GAO	General Accounting Office
HFEF	Hot Fuel Examination Facility
LOFT	Loss of Fluid Test Facility
PBF	Power Burst Facility

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CHAPTER 1

INTRODUCTION

PLANNING AND APPROVAL OF CONSTRUCTION PROJECTS

AEC's Division of Construction furnishes staff judgment on construction estimates to AEC Headquarters divisions and offices and reviews construction project data sheets, requests for architect-engineer work, and other matters relating to construction projects.

Requests for proposed construction projects at AEC's multiprogram laboratories generally originate with the laboratories' operating contractors and are submitted to the cognizant AEC field office for comment. For other contractors the field office is responsible for preparing sound and economical budget estimates and supporting justifications. In preparing such requests, operating funds may be used to perform conceptual design work and to aid in the development of budget estimates.

AEC's instructions provide that conceptual design include the establishment of the scope and general design parameters of construction projects and that it is desirable, in practically all cases, that conceptual design be undertaken prior to the inclusion of a construction project in the budget submission.

Also, since fiscal year 1964, AEC has requested and has been provided with construction planning and design funds to obtain architect-engineer services for complex construction projects which are under consideration for future years' authorizations and appropriations. Such funding enables AEC to perform the design work necessary to develop reasonably reliable cost estimates on such complex projects.

AEC's manual instructions provide that prices used in estimating costs be those of the price level that is current at the time the estimates are prepared, except when instructions are issued to the contrary. Also a contingency reserve should be included to cover costs that may result from unforeseen or unpredictable conditions.

AEC informed us that, in accordance with informal guidance received from the Office of Management and Budget early in calendar year 1969, provisions for cost escalation were included in the contingency reserve for projects having relatively short construction periods. Separate escalation provisions are included for projects to be constructed over long periods.

As part of the budget process, the field offices submit all construction project proposals to the appropriate Headquarters program division for review and include, for each proposed project, a construction project data sheet. Each data sheet includes a description, justification, and cost estimate for the proposed construction project. The data sheets are reviewed by the Division of Construction for conformity with design criteria; soundness of cost estimates; reasonableness of time schedules; and adequacy, pertinence, and consistency of project description statements.

After completion of AEC's budgetary review, the construction project data sheets, as revised during the review, provide the basic support for those projects for which AEC will request authorizations and appropriations.

The Congress authorizes and appropriates separate funds to AEC for operating expenses and for plant and capital equipment. Included in the latter category are amounts for construction, acquisition, or modification of facilities; construction planning and design; and acquisition of capital equipment not related to construction. During fiscal years 1965 through 1971, AEC was appropriated, for plant and capital equipment, approximately $2.5 billion, of which approximately $1.3 billion was related specifically to construction activities.

After a construction project has been authorized and appropriations have been provided, preliminary design work is accomplished by an architect-engineer on the basis of detailed design criteria approved by the field office manager. When projects are considered by AEC to be particularly urgent, AEC has the authority to initiate this design work prior to project authorization.

After approval of the preliminary design by AEC, detailed design work generally is performed by the same architect-engineer who performed the preliminary design. The detailed design work consists of the development of complete construction drawings and related documents and a detailed estimate of the cost of construction.

At the start of construction, the current estimate of the total cost of the project, including any costs which may have been incurred or obligated for architect-engineer services, must be within the start-of-project limitation set forth in the authorizing legislation. The estimated cost shown in the authorizing legislation, plus a stated percentage, either 10 or 25 percent, is referred to as the start-of-project limitation. Normally the percentage for the more complex projects, such as accelerators and reactors, is 25 percent of the estimated cost of the project, and normally the percentage for conventional facilities such as lecture halls, cafeterias, classroom additions, and office buildings, is 10 percent of the estimated cost of the project.

AEC's instructions provide that construction of a project not be initiated by a field office unless the programmatic purpose, scope, location, and operational capacity are within the description of the project as proposed to the Congress for authorization. The instructions provide also that, when these criteria are not met, the matter be referred to AEC Headquarters for a determination as to whether (1) the project may be regarded as one which has been authorized, (2) the project may be regarded as a substitute project, or (3) the project requires further authorization.

STATUS OF ACTIVE CONSTRUCTION PROJECTS

As of December 31, 1970, AEC had 80 active authorized projects. The following tables show the total amount of cost overruns and underruns expected to occur, based on December 31, 1970, cost estimates, and the estimated schedule slippages at that date of all authorized projects. This information has been provided in construction projects reports submitted by AEC annually to the Joint Committee on Atomic Energy, Congress of the United States.

Estimated Cost Overruns or Underruns of Construction Projects

	Number of projects	Estimated cost at time of authorization	Estimated cost as of December 31, 1970	Estimated overrun or underrun(-)
		(millions)		
Projects having estimated underruns	7	$ 41.6	$ 34.9	$ -6.7
Projects having estimated overruns	15	634.9	765.1	130.2
Projects whose current estimates equal amounts authorized	58	533.2	533.2	-
Total	80	$1,209.7	$1,333.2	$123.5

Schedule Slippage of Active Authorized AEC Construction Projects as of December 31, 1970

	Total	No slippage	Slippage (months) 1 to 6	7 to 12	13 to 24	25 to 36	37 or more
Projects having estimated underruns	7	-	1	1	2	1	2
Projects having estimated overruns	15	1	-	2	4	2	6
Projects whose current estimates equal amounts authorized	58	23	8	9	8	7	3
Total	80	24	9	12	14	10	11

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On February 19, 1968, we issued a report to the Joint Committee on Atomic Energy on our "Review of Selected Construction Projects" (B-159687). To provide more meaningful information regarding certain aspects of construction activities, we suggested that AEC

--disclose to the Congress information regarding delays encountered in completing authorized projects,

--incorporate in its instructions a more specific definition of what constitutes a change in project scope, and

--provide information on the related research and development costs associated with projects presented for authorizations when such costs are significant and critical to the successful and timely completion of the projects.

Since the report was issued, AEC has taken action to implement our suggestions.

CHAPTER 2

200-BILLION-ELECTRON-VOLT ACCELERATOR LABORATORY

The 200-billion-electron-volt (Bev.) accelerator laboratory was authorized by the Congress as project 68-4-f under Public Law 90-56 (81 Stat. 124), approved July 26, 1967. The laboratory is being constructed at Batavia, Illinois, under a cost-type contract with Universities Research Association, Inc., a consortium of 52 major universities.

The association has established the National Accelerator Laboratory as the operating organization directly responsible for designing and constructing the accelerator laboratory and for operating the accelerator and associated facilities. The accelerator will provide the highest energy beam of protons of any facility in the world for use in high-energy physics research. Currently the Soviet Union has the highest energy accelerator at about 76 Bev.

The laboratory will be composed primarily of the accelerator, experimental areas, and support facilities. The accelerator itself will be composed of three accelerators: a linear accelerator, a booster accelerator, and a main accelerator ring which will operate in series and which will raise the energy of protons to 200 Bev. or greater by accelerating them around a ring about 4 miles in circumference.

AEC plans initially to provide three experimental areas external to the main accelerator ring, which can be used individually or simultaneously. AEC advised us that additional area for experiments would be added as experience was gained in using these high-energy beams.

Many of the support facilities--such as laboratories, shops, and offices--included in the authorization of the project will be housed in a single high-rise structure of approximately 422,000 square feet. In addition, other laboratory facilities are planned near the experimental areas.

At the time our fieldwork was completed, in September 1970, the construction of the 200-Bev. accelerator laboratory was 34-percent completed. AEC estimated that the total cost of the project would not exceed the $250 million authorized and that the project would be completed on schedule. Initial tests of a 200-Bev. beam are expected in June 1971, to be followed by a period for tuning up and debugging.

It appears that the progress that has been made thus far can be attributed, in large part, to certain techniques used in managing the construction of the accelerator laboratory.

--The laboratory director holds weekly meetings--attended by representatives from his office, the technical sections of the laboratory, the prime construction contractor, and AEC--to discuss all aspects of the construction project, including possible design changes.

--In designing the accelerator, the laboratory has utilized technology developed at other high-energy physics accelerators to the greatest extent possible and thereby has minimized research and development efforts. Furthermore the laboratory has emphasized simplicity and flexibility in design so that future design changes can be incorporated more readily.

--The laboratory has constructed prototypes for each major accelerator component to ensure that the specifications will produce an acceptable component.

--In requesting proposals from suppliers before procuring accelerator components, the laboratory has, on occasion, received suggestions for the simplification and improvement of accelerator components. In such cases the laboratory accepted the improved design, provided that it did not compromise quality.

COST ESTIMATE

AEC estimates that the 200-Bev. accelerator laboratory will cost $250 million. In fiscal year 1968 the Congress provided partial authorization and appropriation for this project of $7,333,000 for architect-engineer work. Through fiscal year 1971 the Congress has authorized the full $250 million, of which it has appropriated $149,407,000.

The March 1969 cost estimate, which accompanied AEC's request for full authorization of the project, included, in addition to a provision for contingencies, a separate provision for cost escalation of about 10 percent of construction and engineering costs.

Through fiscal year 1971 approximately $23 million has been provided to AEC in its operating expenses appropriation for construction related research and development in connection with the project.

AEC's manual states that:

> "After construction begins, a month-to-month review of the estimated cost of the remaining construction work is required in order that the resulting revised estimated total will be a realistic estimate of total probable costs. This is particularly important in view of the additional problem of funding any increases in previous years' projects from each new appropriation. The revised estimated total costs predicted for the project may differ from the official estimate and will be the basis for any revision to the official estimate and financial plan as required."

At the time we started our review, a current estimate of total project costs was not available. The assistant laboratory director advised us that, because of staffing problems and the laboratory's concern with maintaining its construction schedule, priority had not been given to developing current cost estimates.

At our request architect-engineer and laboratory officials prepared estimates of the total costs of various components of the accelerator laboratory as of June 30, 1970, on the basis of costs incurred to date and of the estimated costs to complete the work. The architect-engineer prepared cost estimates and provisions for contingencies for the conventional facilities, and laboratory officials prepared cost estimates and contingency provisions for the technical components.

We assembled this cost information which totaled about $240 million, about $10 million less than the official estimate of $250 million. The following table compares the cost elements of the $240 million estimate as of June 30, 1970--at which time the project was 24-percent completed--with the cost elements of the $250 million estimate as of March 1969.

Cost element	Cost estimates March 1969	Cost estimates June 1970	Over or under(—) March 1969 estimate
	—(millions)—		
Engineering, design, inspection, and administration	$ 34.0	$ 53.3	$19.3
Construction costs:			
Land improvements	6.9	5.8	—1.1
Buildings	34.5	42.3	7.8
Utilities	17.0	22.0	5.0
Other structures	20.7	21.2	.5
Special facilities	70.5	57.4	—13.1
	149.6	148.7	—.9
Standard equipment	10.6	10.5	—.1
Contingency and escalation	55.8	27.1	—28.7
Total	$250.0	$239.6	—$10.4

The favorable cost experience as of June 30, 1970, was attributed by laboratory officials to revision or elimination of certain accelerator components, timely completion of construction contracts, and reduction in estimated construction and procurement costs.

Explanations of the major differences between the above two estimates follow.

1. The increase in engineering, design, inspection, and administration costs reflected the need for making greater than expected engineering and design effort, for constructing prototypes of major accelerator components, and for providing temporary facilities for laboratory employees at the construction site.

2. Building and utility construction cost increases represented escalation resulting from deferral in construction of the conventional facilities so that priority could be given to the design, procurement, and assembly of technical accelerator components.

3. The decrease in the cost of special facilities was associated with (a) a decrease in the energy level of the accelerator booster from 10 to 8 Bev., (b) elimination of a standby preaccelerator system, and (c) decreases in the cost of the main ring and booster magnets.

4. The March 1969 provision for escalation and contingency amounted to $55.8 million. As of June 30, 1970, laboratory and architect-engineer officials estimated that contingency and escalation provisions totaling about $27.1 million would be necessary for uncompleted contracts.

The assistant laboratory director informed us that, from the summer of 1969, the laboratory had been aware that the accelerator laboratory construction costs might be lower than the $250 million initially estimated. The $240 million estimate developed during our review was discussed with various laboratory and AEC field office officials and with the laboratory director in September 1970. The laboratory director stated that the $240 million estimate did not appear unreasonable at that time.

In commenting on the $240 million estimate, AEC stated that:

"The AEC agrees that the $240 million estimate developed during the GAO review of the 200 BeV project in June 1970 at 24% of project completion does not appear unreasonable as a working estimate for the project at that time. It is noted, however, that the 200 BeV facility, which is one of the largest and most complex machines ever built by man, still had many uncertainties at this early stage of completion. The 4% difference between the official $250 million estimate and the $240 million June 1970 estimate is less than the variance among the expert judgments which differ because of the remaining uncertainties and difficulties facing the project during the early stages.

"The AEC and the Laboratory remain highly optimistic, especially in view of the excellent progress to date, that the project will indeed be successfully completed on schedule and within the $250 million authorization.

"The most recent comprehensive review of the cost estimate ($250 million), was made in early March 1971 at 54% of construction completion, using the combined team efforts of *** [the architect-engineer], *** [laboratory officials,] and the local on-site AEC 200 BeV area office representatives. Each of these three organizations has its own special expertise to offer in the review in different areas of technology and management, etc."

The assistant director of the laboratory informed us that the March 1971 estimate had been developed by obtaining (1) actual costs incurred plus outstanding commitments as of December 31, 1970, (2) estimates from laboratory section leaders and the architect-engineer of commitments to be made for the 6-month period January through June 1971, and (3) estimates based on judgment and knowledge for the period beyond fiscal year 1971. The manager of AEC's 200-Bev. Accelerator Facility Office advised us that the laboratory's estimate had appeared reasonable and that he had accepted it without modification.

Our review of the supporting data for the March 1971 cost estimate showed that records had not been developed at the laboratory to indicate how the above-described supporting data had been used in arriving at the $250 million estimate. Further, documentation was not available in support of the estimated commitments to be made beyond fiscal year 1971 to complete the various systems constituting the accelerator laboratory. Therefore we were unable to verify the reliability of the estimate.

AEC advised us that it considered that, consistent with the project status, the March 1971 cost estimate had been prepared from information viewed in sufficient depth for a reliable evaluation. We believe, however, that the lack of documentation for the laboratory's March 1971 estimate tends to preclude an effective analysis and evaluation of the estimate and provides a basis insufficient for determining appropriate revisions to the estimate as changes occur in the future.

CONSTRUCTION SCHEDULE

Laboratory officials advised us that the entire project would be completed by December 1973, as shown in the construction project data sheet. Tests of a 200-Bev. beam from the accelerator are expected to begin in June 1971, about a year earlier than originally planned. Laboratory officials stated that the completion schedule had been based on their experience in meeting scheduled completion dates.

A picture provided by AEC showing the accelerator laboratory as of December 1970, at which time the project was 44-percent completed, is shown on page 18.

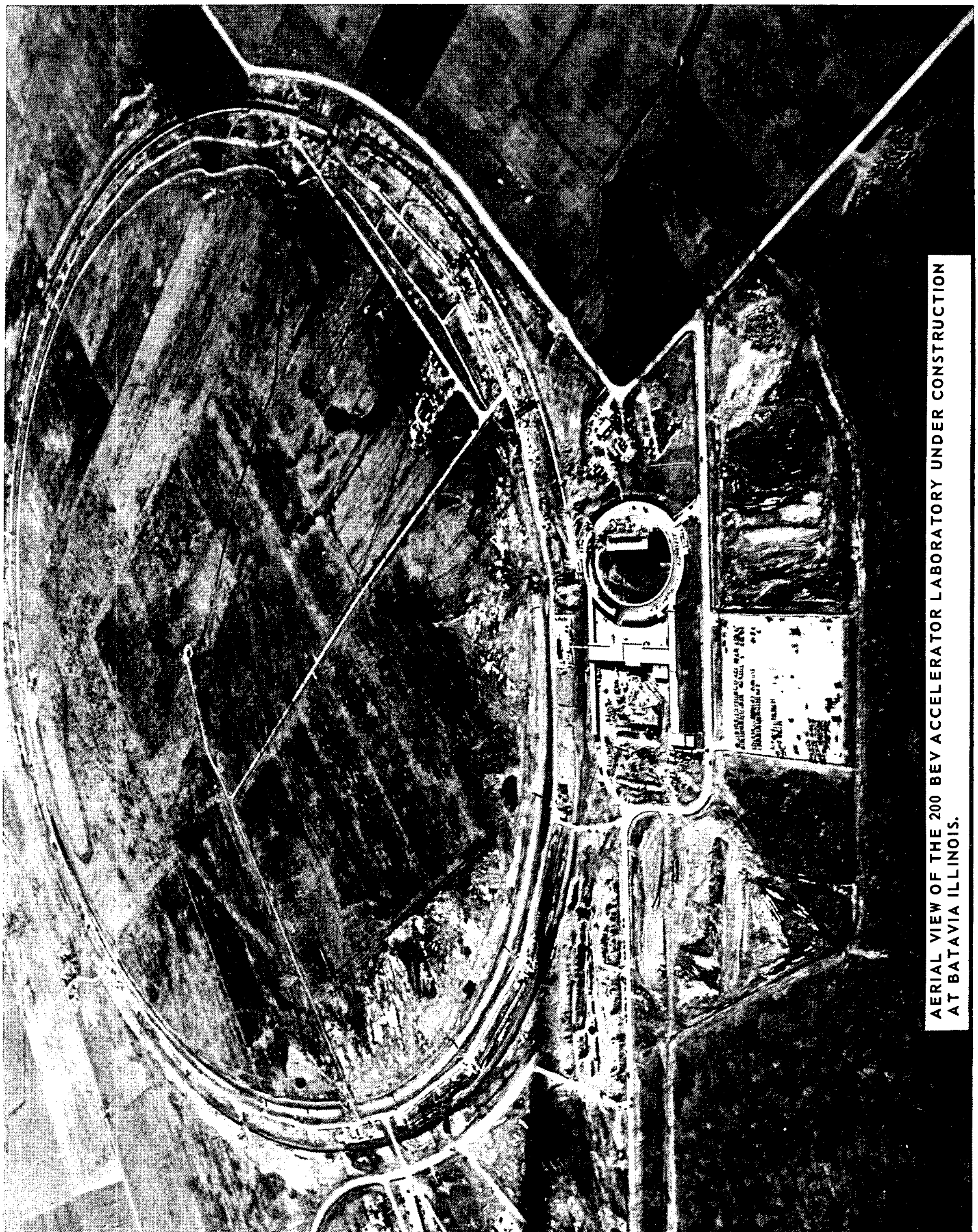
DESIGN CHANGES

The following modifications have been made to the 200-Bev. accelerator laboratory plans shown in the laboratory's January 1968 design report.

A standby preaccelerator system, estimated to cost about $1 million, was deleted from the laboratory's plans, primarily because of the availability of a preaccelerator for emergency use at Argonne National Laboratory.

An official of the 200-Bev. accelerator laboratory informed us that reduction in the energy level of the booster from 10 to 8 Bev. would increase the reliability and efficiency of the booster and that the main accelerator could compensate for the booster reduction. Other laboratory officials informed us that the modifications had not affected the capability of the accelerator to operate at energy levels of 200 Bev. or higher.

Laboratory officials also advised us that construction of eight industrial buildings, estimated to cost $3.4 million, might be deleted from the current design. The March 1969 construction project data sheet provided for the construction of about 165,000 square feet of industrial space. The assistant laboratory director told us that the laboratory had planned to include this industrial space in 10 buildings; however, after two of the buildings having about 30,000 square feet of space had been completed, further construction was deferred until the design of the experimental areas was completed.



AERIAL VIEW OF THE 200 BEV ACCELERATOR LABORATORY UNDER CONSTRUCTION AT BATAVIA ILLINOIS.

As of September 1970 the laboratory was planning to provide approximately 60,000 additional square feet of industrial space in a multistoried central laboratory building included in the initial authorization of the project and in another structure, which would bring the total to 90,000 square feet. Laboratory officials plan to evaluate the need for additional space as the accelerator design progresses. The $240 million estimate includes the necessary funds to provide 165,000 square feet of industrial space.

The original design of the accelerator included the capability to increase its energy above the 200-Bev. level to 400 or 500 Bev. According to AEC, the option for providing this additional capability was estimated to cost about $25 million and this amount was included in the $250 million estimate. Exercising the option at a later date was estimated to cost an additional $30 million.

AEC stated that the present design would provide the capability to operate at a 400- to 500-Bev. energy level at a reduced pulse rate within the $250 million estimate, largely as a result of technological advances and design innovations. Also these advances are expected to reduce the modifications required to achieve the higher energy range at the normal pulse rate.

CHAPTER 3

LOSS OF FLUID TEST FACILITY

The Safety Test Engineering Program was authorized by the Congress as project 64-e-4 under Public Law 88-72 (77 Stat. 85), approved July 22, 1963. The program would enable AEC to conduct a series of large-scale safety tests which would generate comprehensive data to permit informed decisions regarding design and reactor-siting criteria based on demonstrated and positive engineering information. A total of $19.4 million was authorized for the program. Of this amount, $17.6 million was for the construction of the Loss of Fluid Test Facility (LOFT).

LOFT would enable the investigation of a loss-of-coolant accident which generally was regarded as the most serious of the accidents postulated for water-cooled reactor systems. Because little information was available regarding the consequences of such an accident, it was believed that conservative policies with respect to design and reactor-siting criteria were imposing significant economic penalties on the U.S. power reactor program.

In June 1964 one contractor was given overall responsibility for the LOFT experimental design and the test program. In June 1969 this contractor was replaced by a new contractor. AEC advised us that the change had been made because of problems that the first contractor had experienced in going forward with the project successfully. According to AEC the new contractor's responsibilities were essentially the same but included overall direction of construction activities, for which the responsibility had been assigned previously to AEC's Idaho Operations Office. A similar situation, with respect to contractor responsibility, occurred with the Power Burst Facility. (See p. 33.)

The primary objective of the initial LOFT program was to provide quantitative engineering information concerning the sequence of events and phenomena which take place during a loss-of-coolant accident and concerning the ability of the containment vessel to mitigate the consequences. The approach selected in late 1964 to accomplish the above objective was to perform numerous analytical studies and small-scale tests to study individual parts of an accident. Ultimately these studies and tests were to be climaxed by a loss-of-coolant accident which would destroy the reactor core.

DESIGN CHANGES

After the project had been authorized, a number of changes occurred in the nuclear industry which necessitated a reevaluation of the objectives of the LOFT program and re-examination by AEC of safety information needed concerning loss-of-coolant accidents. The principal changes were (1) an increase in demand for nuclear power plants, (2) an increase in pressure to locate nuclear plants near metropolitan areas, and (3) an increase in the average power level of nuclear plants, particularly during the period 1962 through 1966.

The initial concept of testing in the LOFT facility involved examination of the resistance of containment barriers to the conditions potentially associated with major loss-of-coolant accidents. This containment concept and plant isolation were, at the time, major lines of defense for power reactor systems in guaranteeing public safety. Since 1966, however, increasing reliance has been placed on engineered safety features, particularly emergency core-cooling systems, to guarantee public safety.

In May 1967 the Director, Division of Reactor Development and Technology, directed that the LOFT program include, on a high-priority basis, the investigation of emergency core cooling. He directed also that the planned core-destructive test be eliminated from further consideration, since the requirements for engineered safety system tests probably would fully occupy LOFT resources.

A number of design changes have been made to various LOFT systems. Many of these changes were associated directly with incorporation of a more sophisticated emergency core-cooling system and with redirection of the program in 1967 to investigate such a system.

As of May 1971 the program to be performed with LOFT was to consist of a series of loss-of-coolant tests, during which an emergency core-cooling system was to be operated under various performance conditions. The tests were to permit an evaluation of the capability of the cooling system to prevent the release of radioactive products following loss-of-coolant accidents. The test program also was to include an investigation of the containment safety systems, as well as of radioactive product behavior.

CONSTRUCTION SCHEDULE

LOFT has experienced an estimated schedule slippage of over 6 years. Originally it was to be completed by March 1966. As of November 1970 the facility was only 59-percent completed and was expected to be completed in June 1972. A picture provided by AEC, showing the facility at about the time that this stage of completion was achieved, is shown on page 24.

The reasons for the 6-year slippage in the construction of the facility included design changes, redirection of the LOFT program, upgraded engineering requirements, and management direction problems associated with the project.

Design changes and redirection of LOFT program

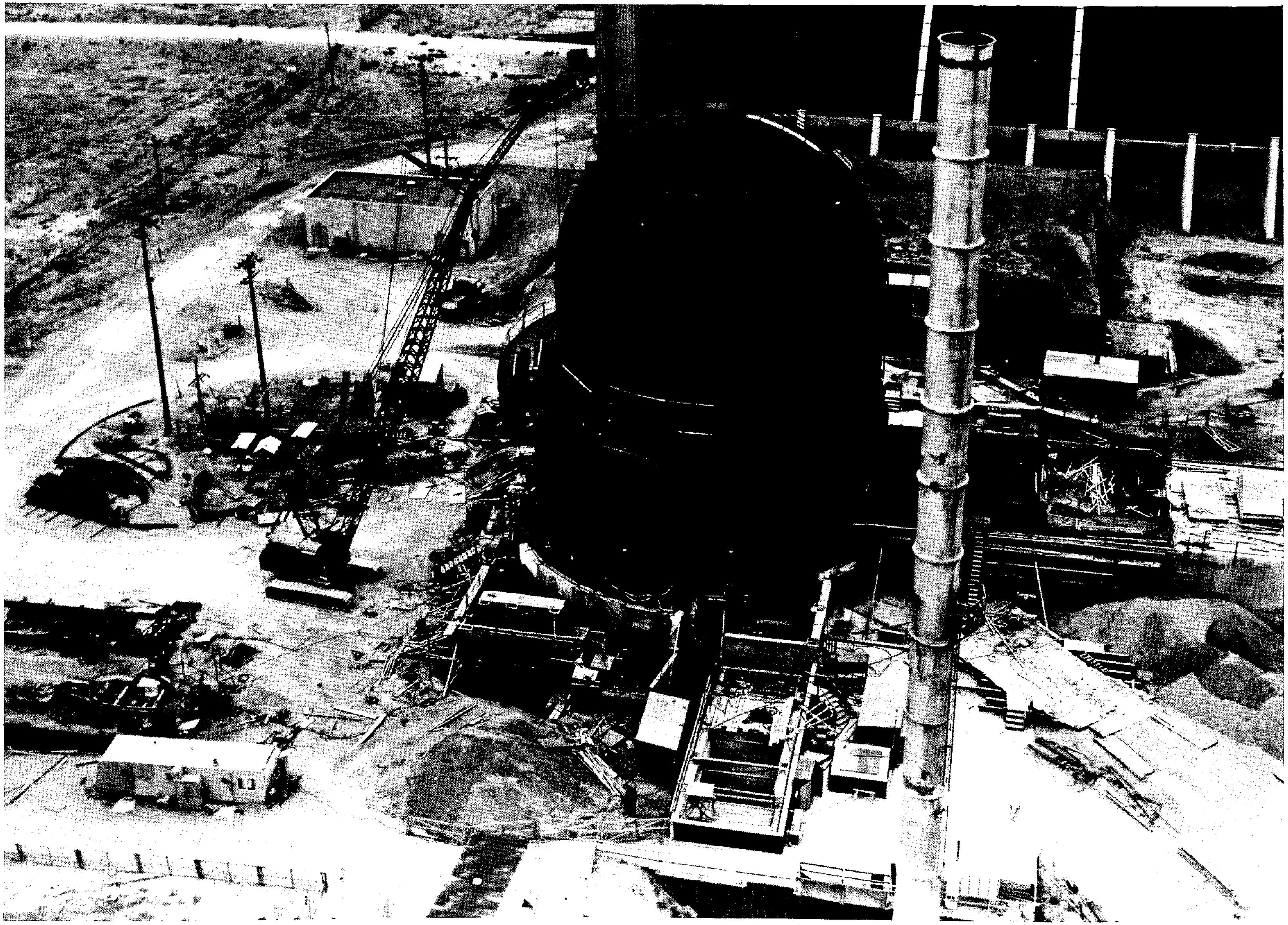
Construction of LOFT was to begin by December 1963; however, the start of construction was delayed about 9 months because of problems encountered in completing the preliminary design.

After construction began the discovery of a lava rock bed directly beneath the containment vessel site necessitated a revision to the design of the bottom part of the vessel. These revisions made the vessel unique, and, as a consequence, about 18 months were needed to solve the new design problems.

The redirection of the LOFT program, as discussed previously, also had a significant impact on the construction schedule, since it necessitated almost a complete redesign of the facilities and test assembly of LOFT.

Upgraded engineering

After the project was started, methods for upgrading engineering, including a quality assurance program and systems design descriptions, were instituted and emphasized by the Division of Reactor Development and Technology because of problems being encountered in the construction of other facilities. According to AEC this action, although needed,



AERIAL VIEW OF THE LOSS OF FLUID TEST FACILITY UNDER CONSTRUCTION AT THE NATIONAL REACTOR TESTING STATION - IDAHO FALLS, IDAHO.

did contribute to the delay of the project. In March 1971 AEC advised us that:

> "The importance and obvious value of the AEC's program for upgrading engineering has been discussed with the Congress since the FY 1966 Hearings, and in particular detail in the JCAE [Joint Committee on Atomic Energy] FY 1968 AEC Authorizing Legislation Hearings, throughout Part 2. In summary, the AEC has accumulated, through years of association with its laboratories and contractors and the nuclear industry, much experience in the planning and execution of R&D [research and development] programs and in the design, construction and operation of test facilities and reactor plants. Numerous problems have also been encountered which have often extended appreciably the time, effort and cost required to complete a project or program. This experience has demonstrated conclusively to the AEC the urgent need to strengthen significantly the engineering practices employed on present and future programs to provide maximum assurance that these programs have the best opportunity to success through the timely and predictable construction and safe and reliable operation of the associated important and expensive facilities. The AEC has further concluded that this strengthening can only be achieved through a systematic engineering approach utilizing exacting engineering standards and quality assurance practices. Abundant experience acquired in building many nuclear power plants demonstrates that this disciplined engineering approach in the long-term is the lowest cost avenue toward meeting these objectives of safe, reliable and predictable operation."

According to AEC another important ingredient in carrying out the design and construction of a nuclear project on a high-quality basis is a design that is methodically developed with careful attention to detail and with firm, well-established requirements. This design is best described for review and evaluation by a systems design description document which provides technical working references of individual systems of a nuclear power plant.

AEC advised us that, until June 1969, problems experienced with the original contractor in developing acceptable systems designs for LOFT had been one of the principal causes of the slippage in the construction schedule. AEC stated that these problems were evidenced by the unacceptable design descriptions that had been submitted for AEC review and approval. As a result of these problems, most field construction work was suspended from May 1968 through October 1970.

At the time of our fieldwork in September 1970, the operating contractor, in conjunction with AEC's Idaho Operations Office, had determined which systems designs were critical in terms of their effects on current estimated completion dates of the facilities and test assembly of LOFT. It appeared to us that the documents supporting the systems designs having the highest priority were being submitted in sufficient time to avoid any additional slippages in the estimated completion dates.

Management direction problems

AEC stated that management direction problems, which had resulted in too much diffusion of responsibility, had contributed to the schedule slippage of the project. AEC informed us that after 1967 measures had been taken to strengthen project management at AEC Headquarters, particularly with respect to applying a systematic and disciplined engineering approach embodying engineering standards and strong quality assurance measures.

This approach was reflected in steps to increase the number and capabilities of employees assigned, to provide needed additional experience in design and construction aspects of nuclear power plants. These actions were accompanied by measures to strengthen coordination both within the Headquarters organization and between Headquarters and the field activities.

In April 1969 the position of Special Assistant to the Director, Division of Reactor Development and Technology, was established for the LOFT project. The Director stated that priority would be exerted to bring the project to successful completion.

In May 1969 the LOFT Project Division was established at the Idaho Operations Office, to focus responsibility for the project at that level.

COST ESTIMATE

In September 1962 LOFT was estimated to cost $17.6 million. AEC indicated that this estimate, which accompanied AEC's request for authorization, included a provision for cost escalation as a percentage of the estimates for material and direct labor projected over the anticipated construction period. The following table shows the increases which have occurred in the estimated construction costs.

Cost element	Cost estimates: September 1962	Cost estimates: June 1970	Over or under(-) September 1962 estimates
	(millions)		
Construction	$11.20	$24.40	$13.20
Engineering, design, and inspection	2.50	7.90	5.40
Contingency	3.90	2.70	-1.20
Total	$17.60	$35.00[a]	$17.40

[a]The Congress was advised of this revised cost estimate in April 1969, and the necessary funds were made available through additional appropriations and underruns on other projects.

AEC attributes the increased costs to

--changes to the plant design and schedule to incorporate provisions for conducting tests of more importance to reactors currently being constructed, particularly tests of emergency core-cooling systems;

--increased costs associated with escalation of indirect construction and inspection due to time extensions;

--increased costs associated with the containment shell and containment vessel door; and

--provisions for upgraded engineering and quality assurance and revised safety requirements.

The estimated operating funds to be expended for this project have increased substantially. Originally about $19 million was to be expended from May 1964 through December 1969. As of May 1971 about $48 million was expected to be expended through June 1972, the estimated completion date for the construction-funded portion of the project. LOFT is scheduled to begin nuclear operations by December 1973. The redirection of the LOFT program and the schedule slippages were the principal causes of the significant increases in operating funds.

CHAPTER 4

POWER BURST FACILITY

The Power Burst Facility (PBF) was authorized by the Congress as project 65-4-b under Public Law 88-332 (78 Stat. 228), approved June 30, 1964. PBF was justified by AEC on the basis of a need for more definitive information on safety requirements for reactor facilities. Because of the need for this information, many complex safety features, which had not been tested and which may not have been required, were being incorporated into the designs of all reactors.

The primary purpose of PBF was to study and understand the phenomena associated with the failure of reactor fuel assemblies when subjected to deviations from the normal temperature, pressure, and flow characteristics of an operating reactor.

The justification which accompanied the authorization request indicated that PBF was required to support certain aspects of the nuclear safety program. The project was to be started by December 1964 and was to be completed by June 1966.

COST ESTIMATE AND DESIGN CHANGES

The total estimated cost of the project, as authorized, was $8.1 million. AEC indicated that this amount included a provision for cost escalation as a percentage of the estimates for material and direct labor projected over the anticipated construction period.

At the time physical construction was started in September 1965, the total estimated cost was $9.4 million which was within the start-of-project limitation of 125 percent of the amount authorized by the Congress.

As of June 30, 1970, the total estimated cost was $16.1 million, of which $8 million represented increased costs, as shown in the following table.

Cost element	Cost estimates January 1964	June 1970	Over or under(-) January 1964 estimates
Engineering, design, and inspection	$1,300,000	$ 3,420,260	$2,120,260
Construction	5,175,000	12,323,412	7,148,412
Contingency	1,625,000	406,328	-1,218,672
Total	$8,100,000	$16,150,000[a]	$8,050,000

[a]The Congress has been advised of increases in the cost estimate, and the necessary funds have been made available from underruns on other construction projects.

The $8 million increase in cost was attributed by AEC to

--upgraded engineering requirements instituted by AEC, which included a quality assurance program and a requirement for systems design descriptions;

--cost escalation associated with schedule slippage; and

--major design change from a facility which would provide limited power bursts to one which could be operated at a constant, or steady-state, power level.

As authorized, PBF was to provide power bursts as short as 1 millisecond (one thousandth of a second). In April 1965, about 5 months prior to the start of construction, the architect-engineer was instructed to incorporate into the PBF design the operating capability for a constant, or steady-state, power level. This was considered a major design change, which necessitated design changes in nearly all aspects of the project, to enable scientists to broaden the ability to simulate the types of accidents described in the original PBF concept and to increase the reliability of the resulting experimental data. The additional cost was estimated at about $1.3 million.

In an April 1967 letter, replying to an inquiry from the Joint Committee on Atomic Energy concerning the status of several construction projects, AEC indicated that:

> "A major design change was made on the PBF when it was decided to incorporate a steady state (20 megawatts) power operating capability in the PBF. The original design was limited to the performance of short period excursions. This design change will permit greater flexibility in the type of accidents that can be simulated in the PBF."

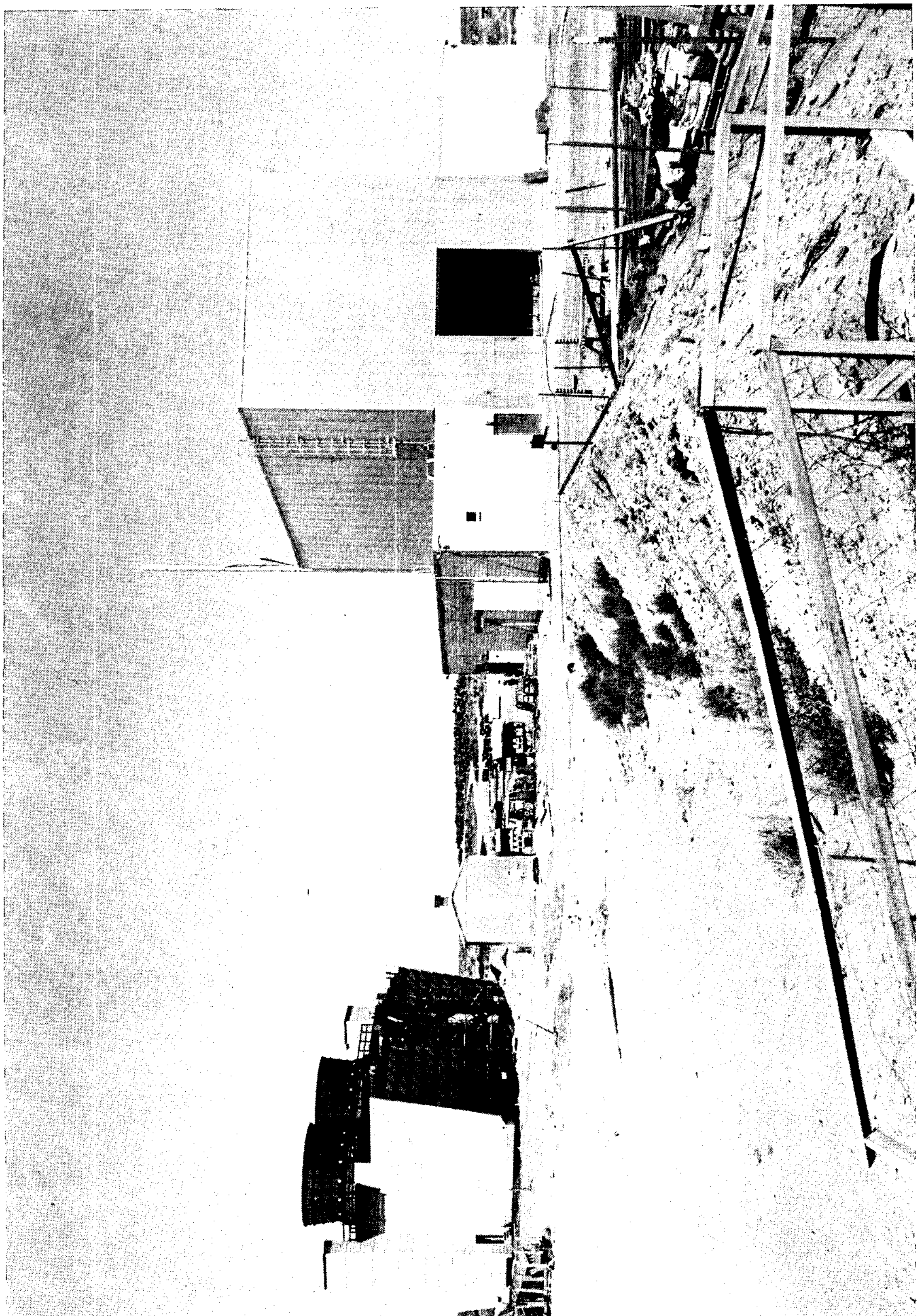
CONSTRUCTION SCHEDULE

PBF has experienced a schedule slippage of over 4 years. At the time of authorization, PBF was scheduled to be completed by June 1966; however, construction work was nearly completed as of September 1970 and the test program was planned to begin around October 1971. A picture of PBF, which was provided by AEC, is shown on page 32.

AEC indicated that the 4-year delay had resulted from (1) design changes due to the incorporation of a steady-state power level capability, (2) implementation of quality assurance requirements, (3) deficiencies in the architect-engineer's initial design, and (4) management direction problems similar to those discussed for the LOFT project. (See p. 26.)

Physical construction of the project was scheduled to begin by December 1964. The addition of the steady-state power level capability to PBF, however, resulted in a redesign of almost all project systems and delayed the start of construction until September 1965.

AEC advised us that, after physical construction began, the major part of the schedule slippage which occurred from about February 1966 to January 1968 was attributable to the contractor's implementation of the quality assurance program. This program was part of AEC's plans for upgrading engineering and design revisions required as the result of disclosed quality assurance deficiencies. The contractor



VIEW OF THE POWER BURST FACILITY CONSTRUCTED AT THE NATIONAL REACTOR TESTING STATION - IDAHO FALLS, IDAHO.

was required to perform, as part of the quality assurance program, an in-depth design and construction review of each system component. AEC Headquarters required such a review before authorization could be given to procure the component.

AEC informed us that the original contractor had not effectively implemented the design review and that many deficiencies in the design of PBF had been disclosed subsequently and had to be corrected before construction could proceed. As a result, schedule slippages occurred in procuring the PBF reactor system components. As discussed on page 25, AEC has placed considerable emphasis on the importance of strengthening engineering practices in reactor development projects.

AEC informed us also that the construction contractor had limited experience in the procurement of engineered components for a reactor plant and that this situation had resulted in significant delays.

The management direction problems which existed with the LOFT project also existed, to a large extent, with the PBF project. AEC informed us that the actions which had been taken to solve the problems with LOFT also had been taken on PBF, except that no specific division for PBF had been established at the Idaho Operations Office because the project was nearly completed.

As a result of schedule slippages, the estimated operating funds related to the project have increased from about $4.1 million to be expended from March 1965 to March 1968 to the current estimate of about $18 million through fiscal year 1971.

CHAPTER 5

FAST FLUX TEST FACILITY

On May 21, 1966, the Congress authorized the Fast Flux Test Facility (FFTF) as project 67-3-a under Public Law 89-428 (77 Stat. 88). The authorization provided $7.5 million for architect-engineer services needed to design the project. In July 1967 the Congress authorized an additional $80 million for construction, which brought the total to $87.5 million.

FFTF was designed to be a 400-megawatt facility for testing reactor fuel, components, and systems for the development of technology primarily for the Liquid Metal Fast Breeder Reactor program. It is planned that FFTF will include a reactor having such support facilities as heat-removal and fuel-handling systems, fuel examination facilities for reactor material and components, and the necessary maintenance and office facilities.

The Liquid Metal Fast Breeder Reactor program is AEC's highest priority civilian nuclear power program. The objective of the program is to develop and demonstrate the safe, reliable, and economical implementation of fast breeder reactor power plants so that utility groups can use them by the mid-1980's. The program involves not only participation by AEC laboratories but also participation by a significant number of industrial and utility companies.

AEC plans to first apply the technology developed with FFTF to the construction, in conjunction with reactor manufacturers, of one or more liquid metal fast breeder demonstration plants scheduled for completion in the late 1970's or in the early 1980's. AEC believes that the technology ultimately will be used for designing the commercial fast breeder reactor in the 1,000-megawatt range. An artist's conception of FFTF, which was provided by AEC, is shown on page 38.

COST ESTIMATE AND DESIGN CHANGES

As of June 30, 1970, AEC estimated that FFTF would cost $102.8 million. This amount was within the 125-percent start-of-project limitation but was about $15 million greater than the September 1966 estimate of $87.5 million which accompanied AEC's request for authorization, as shown by the following table.

Cost element	Cost estimates: September 1966	Cost estimates: June 1970	Over or under (-) September 1966 estimate
	(millions)		
Engineering, design, and inspection	$11.0	$17.0	$ 6.0
Construction:			
Reactor system	22.5	29.9	7.4
Closed test loops	7.7	3.0	-4.7
Fuel handling and storage	3.2	2.2	-1.0
Buildings, structures, cranes, and electrical and miscellaneous services	11.3	15.4	4.1
Interim fuel examination facility	5.2	3.9	-1.3
Containment	3.2	8.3	5.1
Nuclear proof test facility	1.3	-	-1.3
Maintenance facility	1.8	1.8	-
Total	67.2	81.5	14.3
Additions	-	0.9	0.9
Contingency	20.3	20.4	0.1
Total	$87.5	$102.8[a]	$15.3

[a]The Congress has been advised of the increases in the cost estimate for FFTF. Through fiscal year 1971, $59.7 million was appropriated for the project.

AEC advised us that the cost estimate of $87.5 million had been based on a composite of potential concepts and on an assessment of costs by management and that the contingency provision was about 30 percent of all other costs and included a factor for cost escalation.

After preparation of the September 1966 cost estimate and after the evaluation of many reactor-core concepts, a definitive design was developed which, in AEC's judgment, could be built and would meet the objectives of the project.

An explanation for the increases and decreases follows.

1. The definition of the plant concept resulted in total increased costs of $16.6 million, of which $7.4 million was related to the reactor system, $4.1 million to buildings and structures, and $5.1 million to the containment facilities. The original cost estimate for the closed test loops was high because of uncertainties related to their capability of being incorporated into specific plant concepts. The selected plant concept accomplished this capability with an estimated $4.7 million reduction in costs.

   The plant concept selected was similar to that expected to be used in commercial liquid metal fast breeder reactors, and its design would enable the removal of certain reactor components without a complete removal of the top part of the reactor. AEC had determined that this plant concept would meet the objectives and scope described in the construction project data sheet.

2. The $1 million decrease in fuel handling resulted from the simplification of the fuel-handling systems for the selected plant concept. According to AEC this simplification was accomplished at the expense of an increase in the cost of the reactor and reactor vessel.

3. AEC deferred indefinitely the $1.3 million nuclear proof test facility due to the budgetary stringencies subsequent to authorization of the project. AEC did

not consider this facility to be essential for initial operation, since the physics experiments that it was designed to perform already were being carried out in other AEC facilities. During the fiscal year 1971 authorization hearings before the Joint Committee on Atomic Energy, AEC indicated that it still would like to construct this facility.

4. The $1.3 million decrease in the interim fuel examination facility resulted from design changes.

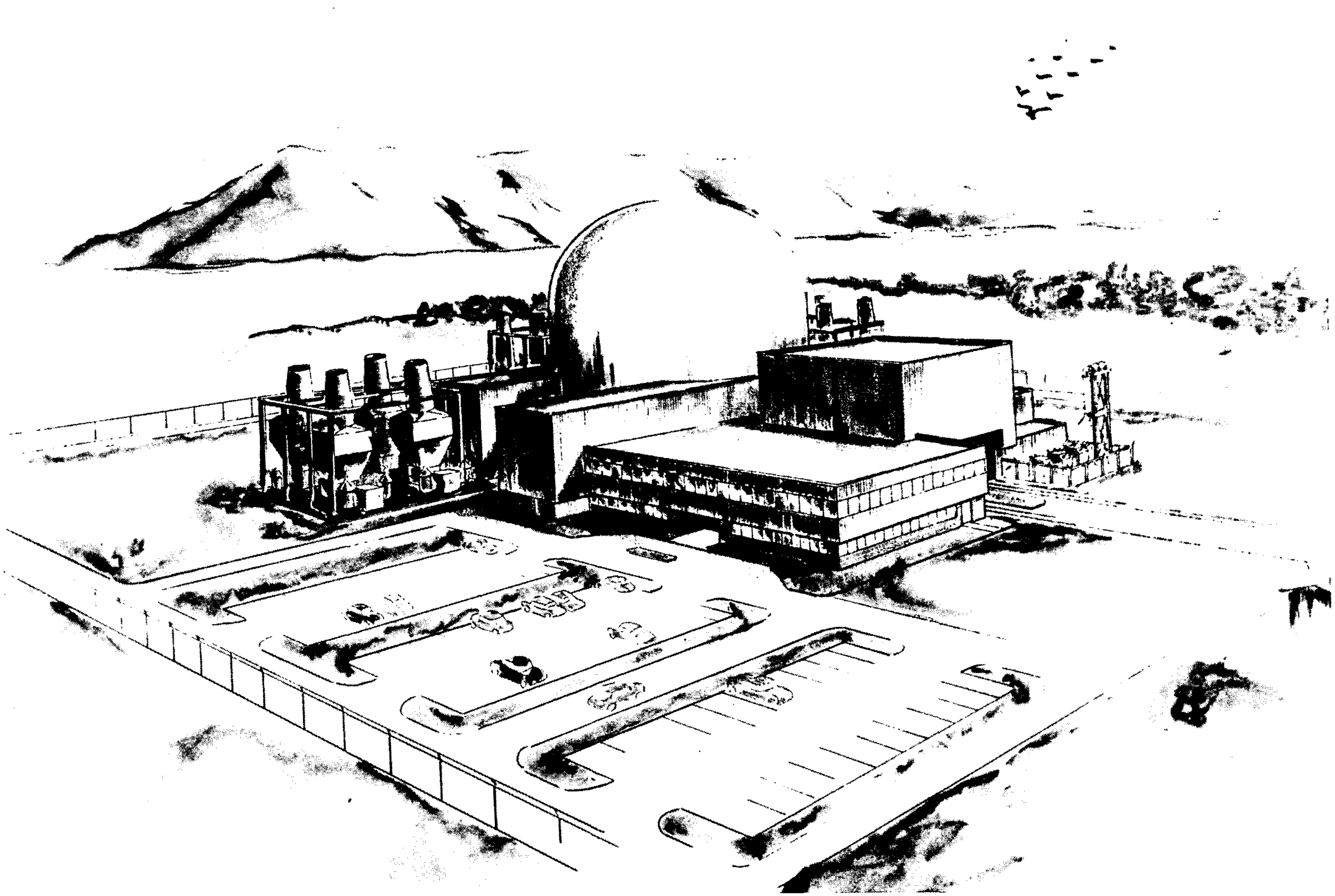
As of June 30, 1970, AEC had expended about $60 million of operating funds for research and development related to the FFTF project. At the time that construction was authorized in fiscal year 1968, AEC estimated that about $41 million would be necessary for research and development through fiscal year 1970 and that $31 million more would be needed through fiscal year 1973.

As of September 1970 AEC estimated that about $151 million of operating funds would be necessary for the construction-related research and development work and other expenses associated with the project. AEC attributed this increase to the (1) need for more research and development work than that originally anticipated, (2) need to strengthen the capability of accomplishing the research and development, (3) increased costs related to the development of hardware prototypes, and (4) cost escalation. AEC indicated that there was a need also to devote a greater effort to the development of the technological base required to go forward with the project.

CONSTRUCTION SCHEDULE

The Congress authorized the construction of FFTF in July 1967, and at that time AEC estimated that construction would start by June 1968 and would be completed by April 1973. Construction started in July 1970, however, and, as of May 1971, AEC estimated that the project would be completed by June 1974, about 1 year later than originally estimated.

In our September 23, 1970, report to the Congress on the "Problems in Developing the Atomic Energy Commission's



ARTIST'S CONCEPTION OF THE FAST FLUX TEST FACILITY UNDER CONSTRUCTION AT RICHLAND, WASHINGTON.

Fast Flux Test Facility" (B-164105), we noted that the delay of the project had been caused by management problems. Specifically, the problems related to the fact that AEC's Pacific Northwest Laboratory had not established an engineering-oriented organization having sufficient management and technical capabilities to develop such a complex project and to the fact that AEC, with its various levels and dispersion of management, had not effectively brought about changes in organization and design approaches that had been identified and determined to be essential.

In that report we suggested that AEC review the reactor development and technology organization and all levels of contractor and laboratory management involved with the project, to streamline the organization, to strengthen the communication and technical review channels, and to provide some assurance that management and staff would make maximum contributions to this high-priority project.

In response to our suggestion, AEC stated that actions which were intended to establish clear lines of responsibility and unequivocal authority had been taken or were being taken. AEC has agreed to keep us apprised of the progress and status of the project in order that we may evaluate the effectiveness of the actions taken to improve project management.

CHAPTER 6

HOT FUEL EXAMINATION FACILITY

The Congress authorized $10.2 million for the Hot Fuel Examination Facility (HFEF) as project 69-4-a under Public Law 90-289 (77 Stat. 88), approved April 19, 1968. HFEF was designed to contribute to the development of fuel elements for the fast breeder reactor program by providing a facility for the examination of reactor fuels and structural materials which had been irradiated in the Experimental Breeder Reactor II, a principal irradiation test facility of the Liquid Metal Fast Breeder Reactor program, at the National Reactor Testing Station in Idaho. HFEF was planned to be a one-story building having a hot cell examination complex and associated support facilities.

PLANNING AND AUTHORIZATION OF HFEF

The need for additional examination capability at the testing station has been recognized by officials of AEC's Argonne National Laboratory since 1966, when the role of the Experimental Breeder Reactor II was changed from that of a demonstration reactor to a test facility for the Liquid Metal Fast Breeder Reactor program.

On February 27, 1967, AEC authorized Argonne to begin conceptual design work on HFEF. On April 5, 1967, AEC informed Argonne that HFEF should be a complete examination facility, primarily to support the irradiation work being conducted at the Experimental Breeder Reactor II. Also AEC asked Argonne to consider the desirability and reasonableness of modifying the Fuel Cycle Facility, a nearby test facility, rather than constructing HFEF.

In an April 28, 1967, letter, Argonne stated that it considered the modification of the Fuel Cycle Facility to be impracticable because (1) it would require interrupting the operation of the only existing fuel production facility for the Experimental Breeder Reactor II as a result of the extensive modification needed, (2) work would have to be diverted to some other facility during modification, which would be costly, and (3) the facility was being considered in connection with the processing of future fuels.

Conceptual design of HFEF was initiated by Argonne. In September 1967 Argonne estimated that it would cost $23.5 million to provide a complete examination facility incorporating all the capabilities specified by AEC. Because of the relatively high estimated cost, Argonne officials reviewed the design and estimate and concluded that a minimum-sized, fully equipped facility could be constructed for about $18 million. Argonne officials indicated that the reduction would be accomplished by reducing the size of the facility by about one third and by eliminating selected equipment items.

The design of the facility was based on the types of examination capability to be required. According to AEC reliable estimates of the work load were not available because the estimates depended heavily on the results of the work to be performed primarily at the Experimental Breeder Reactor II and, since this was a research and development program, the results were unpredictable.

In September 1967 AEC informed Argonne that the cost of HFEF should not exceed $10 million. Argonne officials advised us that this reduced funding level had necessitated significant changes in the design of HFEF.

On October 3, 1967, Argonne informed AEC that a facility having reduced capability could be constructed for about $9.7 million. Argonne informed AEC also that:

> "Previous work has indicated that it would be undesirable and impractical to use FCF [Fuel Cycle Facility] for those overall functions currently intended for HFEF. However, it appears possible that some space could be made available in the FCF for certain types of examination work. This approach will be investigated further and will be defined at the time of submission of the Feasibility and Cost Study. It is not intended that any of the work associated with FCF modifications or equipping will be borne as an HFEF Project effort. Conversion of portions of the FCF will come only after the current FCF production activities have been concluded."

In January 1968 AEC requested congressional authorization of $10.2 million for the construction of HFEF, which was to be completed by March 1971. AEC informed us that the cost estimate which had accompanied the request for authorization had included a provision for cost escalation as a percentage of the estimates for material and direct labor projected over the anticipated construction period.

The construction project data sheet and the testimony at the authorization hearings for fiscal year 1969, conducted in February 1968, did not call attention to the fact that the expected work load for HFEF had not been estimated or to the fact that Argonne National Laboratory was considering the modification of the Fuel Cycle Facility to provide additional capability. The data sheet indicated that no suitable facility was available for the examination of irradiation experiments.

We believe that, when authorization is requested so that a project can provide a particular capability, AEC should advise the Congress, either in the construction project data sheet or during the hearings before the Congress on AEC's budget request, of significant expenditures that will be required to provide the capability in existing facilities of augmenting that planned for the new facilities. This would give the Congress more complete information on which to base its decision regarding whether the project should be funded.

AEC advised us that, consistent with its policy of keeping the Congress informed of significant developments in its projects and programs, information regarding the use of the Fuel Cycle Facility in connection with HFEF operations should have been provided at the time HFEF was authorized but that the information had been omitted by oversight. The information was provided during the fiscal year 1971 authorization hearings.

DESIGN AND CONSTRUCTION

HFEF, as authorized by the Congress, was to have a gross area of 43,500 square feet. Subsequent to authorization, work-load requirements were studied and revised designs were proposed.

In November 1968 Argonne completed another design study and cost estimate which included significant changes from previous designs. The shielded equipment storage cell would be eliminated, all decontamination functions would be consolidated in one examination cell, and HFEF would be relocated. The estimated cost of HFEF as redesigned was about $11.4 million.

In December 1968 Argonne suggested certain changes totaling about $1.2 million to reduce the estimated cost to $10.2 million. The changes which were made are shown in the following table.

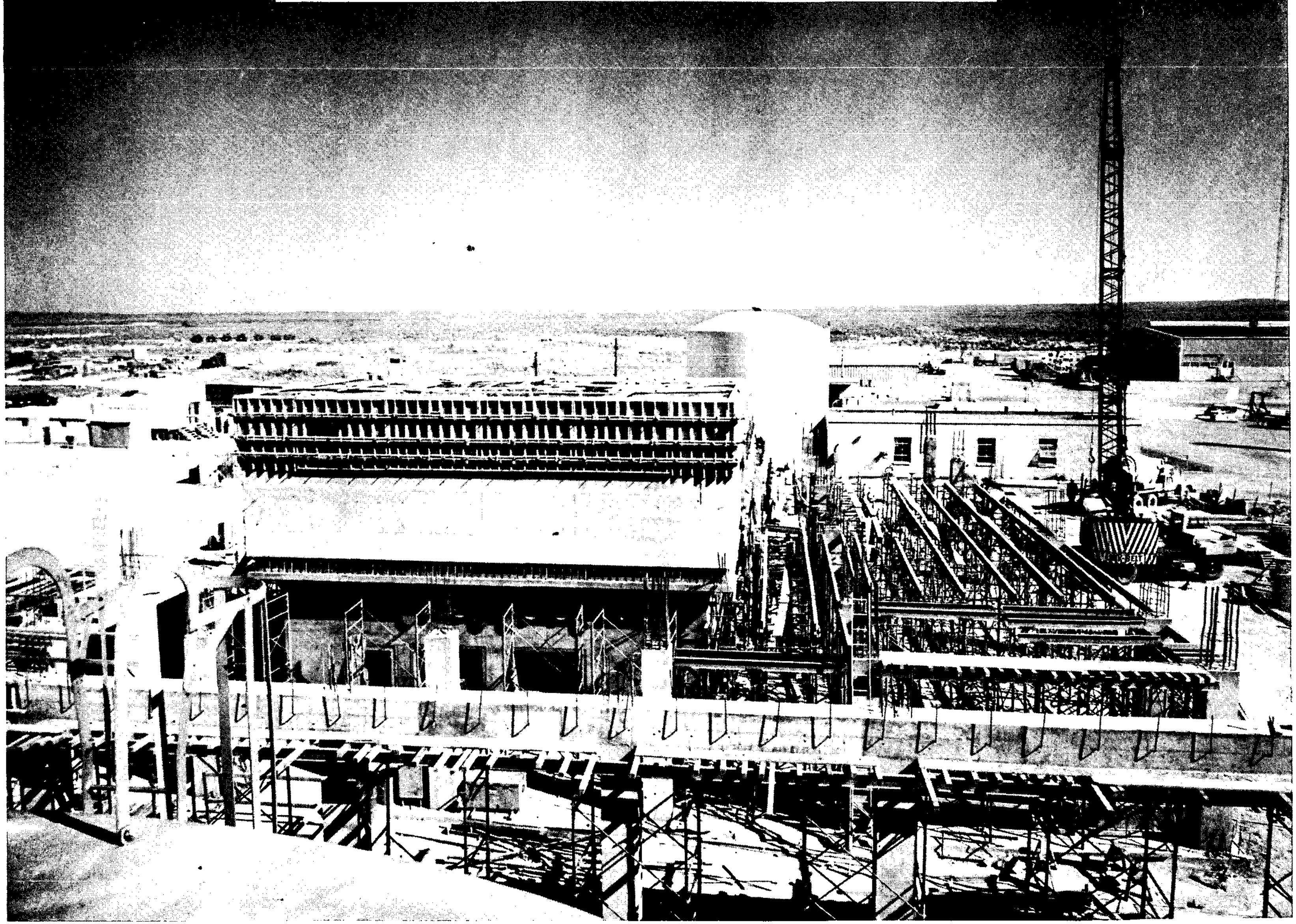
Suggested change	Estimated saving
Eliminate clean cell	$ 680,000
Reduce shielding thickness	90,000
Remove shielded repair cell	108,000
Reduce size of work station module	157,000
Modify three work stations	144,000
Total	$1,179,000

In April 1969 Argonne submitted to AEC the preliminary design report for HFEF which provided for a 56,570-square-foot facility, estimated to cost $10.2 million, to be completed by June 1972.

The design report referred to the project as the HFEF-Fuel Cycle Facility examination complex and indicated that 13 work positions would be available and equipped at the complex when HFEF was completed.

Construction of HFEF was started in July 1969. As of October 1970 it was about 35-percent completed and was expected to be finished in June 1972, more than a year later than originally anticipated. According to AEC the delay was attributable, in large part, to the fact that funds for design work had not been available as early as anticipated. A picture provided by AEC, showing the facility as of October 1970, is on page 44.

VIEW OF THE HOT FUEL EXAMINATION FACILITY UNDER CONSTRUCTION AT THE NATIONAL REACTOR TESTING STATION - IDAHO FALLS, IDAHO.



In a March 1970 letter, AEC advised us that, as of January 1970, about $1 million had been expended to upgrade and equip the Fuel Cycle Facility to meet the then-current examination requirements. AEC estimated that it would spend $4 million additional, of which $2 million would be used for modifications and equipment prior to the start of HFEF operations in June 1972 and $2 million thereafter.

As of June 1970 AEC estimated that HFEF could be constructed for $10.2 million and stated that the types of capability to be provided generally agreed with those indicated in the construction project data sheet. Thus the total estimated expenditures associated with the HFEF-Fuel Cycle Facility examination complex were about $15.2 million. AEC informed us that, as of May 1971, no change had been made to that estimate.

CHAPTER 7

REPORTING SYSTEM

INTERNAL REPORTING SYSTEM

AEC requires a Monthly Progress Report for Construction Jobs for each project costing more than $100,000. The report includes (1) a description of the work, (2) the date the work started, (3) the scheduled final completion date, (4) the scheduled and actual percentage of completion, (5) the present working estimate, and (6) any significant comments.

A special Progress Forecasts report is required on each project estimated to cost $5 million or more. This report is required 90 days after construction has started and subsequently whenever there is a significant change in the construction activities or a change in the completion date. The report must include the reasons for the changes in forecasts and/or scheduled dates, including all contributing factors such as labor shortages and strikes.

The AEC manual establishes provisions for a reporting system whereby more detailed cost reports are used at the field office level and whereby summary reports are submitted to Headquarters to aid in overall control of project costs and commitments. Reporting is flexible in format and in the amount of detail provided and is contingent on circumstances surrounding a given project, such as whether the work contracted for is by lump-sum, fixed-price, or cost-plus-fixed-fee contract.

The reports used by the field offices provide sources of information to assist management in controlling costs and include more detailed information than that provided in the summary reports for AEC Headquarters use. The reports provide more detailed information on the phases of construction projects currently active and less detail on the phases of projects not started or previously completed.

The summary cost reports and estimates are prepared by the contractor for the use and information of persons more remote from construction activities. The summary reports are reviewed by AEC field office employees; are signed by the managers or their delegated representatives, as evidencing the correctness of the costs and agreement with the estimates contained in the reports; and then are submitted to AEC Headquarters.

Within AEC Headquarters, the Division of Construction is responsible for informing appropriate officials of the status of construction projects and for promptly reporting potential problem areas which may affect construction schedules and cost estimates. This is accomplished, in part, by reports on visits to facilities under construction.

The 200-Bev. accelerator laboratory project is under the cognizance of AEC's Division of Research. All other projects included in this report were under the cognizance of the Division of Reactor Development and Technology.

<u>200-Bev. accelerator laboratory</u>

In planning for the organizations required to bring the laboratory into being, AEC recognized the need for onsite management control because of the size, complexity, and schedule of the project. Therefore, in the early stages of the project, AEC established the 200-Bev. Accelerator Facility Office which has a staff of about 20 people and which is located at the project site.

Facility office employees maintain a day-to-day working relationship with the laboratory administrative and management employees, to ensure that the laboratory's actions are consistent with the administrative rules and regulations of AEC and to maintain a detailed working knowledge of the project.

At the time of our review in September 1970, the laboratory had not developed complete procedures for estimating and reporting costs in the monthly summary cost and estimate reports. AEC 200-Bev. Accelerator Facility Office officials did not require the laboratory to prepare detailed monthly cost reports and estimates. An area office official advised us that the type of information provided in the detailed cost reports, such as breakdowns of material and labor costs, was not considered necessary to keep abreast of the current status of the project.

The summary cost reports and estimates prepared by the laboratory from August 1969 to August 1970, in the early stages of the project, continued to show the total cost estimate of $250 million. When actual costs had been determined on completed procurement or construction contracts and were in excess of estimates, the overruns were deducted from the escalation provision. No summary cost report was provided to AEC in September 1970, because the laboratory was revising the cost estimates. Since October 1970 the laboratory has issued revised cost estimates in which the individual cost elements have been adjusted to reflect current estimates.

AEC's March 1971 cost estimate showed that the total project cost still remained at $250 million. As discussed on page 16, the procedures used in arriving at this estimate were not adequately documented, which precluded an effective analysis and evaluation of the estimate.

<u>Division of Reactor Development and Technology projects</u>

The management concept utilized by the Division of Reactor Development and Technology provides that Headquarters' representatives be resident at each contractor site deemed necessary by the division director. The role of these site representatives is to keep the division apprised of the progress of contractor activities and to emphasize the technical aspects of such activities. In carrying out their role, the site representatives prepare periodic reports, usually on a weekly basis, and provide additional information at the request of the director.

A number of reports were generated in connection with the construction of LOFT, PBF, FFTF, and HFEF, which were designed to inform AEC of cost and schedule changes, design revisions, and other events associated with the projects. Generally the information contained in these reports was adequate to keep AEC informed of the progress and status of the projects.

EXTERNAL REPORTING SYSTEM

AEC keeps the Congress informed of the status of its various construction projects, in part, by furnishing a number of tables in connection with each year's budget request. The tables show the estimated or, where applicable, the actual costs and completion dates of projects which are under construction, are to be started, or are completed. Also furnished are a number of other tables, such as one showing the projects under construction for which the estimated costs have exceeded the start-of-project limitation. The tables are prepared as of December 31 and are published as part of the Joint Committee on Atomic Energy hearings on AEC's annual authorization requests.

AEC has supplied the Congress with current cost and schedule information regarding the projects included in our review. Also AEC has given substantial information to the Congress concerning the design aspects of its construction projects.

CONCLUSIONS

We believe that the various types of reports being utilized by AEC and its contractors at the time of our review in September 1970 generally provided adequate mechanisms for communicating information related to the cost, schedule, and design aspects of construction projects. With respect to the 200-Bev. accelerator laboratory project, however, we believe that the procedures used in developing current working estimates reported to AEC should be strengthened to provide a better basis for analysis and evaluation.

We therefore suggested that AEC, together with appropriate contractor officials, review the laboratory's cost-estimating practices used for the 200-Bev. accelerator and make appropriate revisions, to ensure that the estimates prepared will be adequately documented to facilitate effective analysis and evaluation.

AEC pointed out that the 200-Bev. accelerator project was being carried out in a highly satisfactory manner and that it was expected to be completed within the original time and cost estimates and to exceed its performance objectives. AEC agreed, however, that the contractor's estimating practices should be strengthened and took steps to improve these practices.

CHAPTER 8

SCOPE OF REVIEW

Our review was made at (1) AEC Headquarters in Germantown, Maryland, (2) AEC's operations offices in Chicago, Illinois; Idaho Falls, Idaho; and Richland, Washington, and (3) AEC-contractor-operated facilities at the National Accelerator Laboratory, Batavia, Illinois, and the National Reactor Testing Station, Idaho Falls, Idaho.

Our review was directed primarily toward examining into the cost, schedule, and design aspects of five AEC construction projects--the 200-Bev. accelerator laboratory, LOFT, PBF, FFTF, and HFEF. We also examined into AEC's reporting system with regard to its adequacy for communicating information concerning the progress and status of construction projects to AEC Headquarters and with regard to whether significant developments had been brought to the attention of the Congress when appropriate.

As part of our examination, we reviewed pertinent AEC policies and procedures and obtained the views of AEC and contractor employees knowledgeable of, and responsible for, the administration of the projects selected for review. We did not examine into whether the need for the projects was adequately justified or whether the costs incurred were reasonable.

APPENDIX

PRINCIPAL MANAGEMENT OFFICIALS OF THE ATOMIC ENERGY COMMISSION RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
CHAIRMAN:		
Glenn T. Seaborg	Mar. 1961	Present
John A. McCone	July 1958	Jan. 1961
GENERAL MANAGER:		
R. E. Hollingsworth	Aug. 1964	Present
A. R. Luedecke	Dec. 1958	July 1964
ASSISTANT GENERAL MANAGER FOR REACTORS:		
George M. Kavanagh	Jan. 1966	Present
J. A. Swartout	Dec. 1964	Dec. 1965
ASSISTANT GENERAL MANAGER FOR RESEARCH AND DEVELOPMENT:		
Spofford G. English	Aug. 1961	Present
DIRECTOR, DIVISION OF CONSTRUCTION:		
J. A. Derry	Mar. 1954	Present
DIRECTOR, DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY:		
Milton Shaw	Dec. 1964	Present
DIRECTOR, DIVISION OF RESEARCH:		
Paul W. McDaniel	May 1960	Present
FIELD OFFICE MANAGERS:		
Chicago Operations Office:		
Kenneth A. Dunbar	Nov. 1957	Present

	Tenure of office	
	From	To
FIELD OFFICE MANAGERS (continued):		
Idaho Operations Office:		
William L. Ginkel	Nov. 1963	Present
Hugo N. Eskildson, Jr.	Jan. 1962	Nov. 1963
Richland Operations Office:		
Donald G. Williams	July 1965	Present
J. E. Travis	Aug. 1955	July 1965